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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

MINING AND MILLING METHODS AND COSTS AT THE GOLDEN MESSENGER MINE OF THE UNITED GOLD MINES CORPORATION, YORK, MONT.

RECEIVED

BY

S. H. LORAIN

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MINING AND MILLING METHODS AND COSTS AT THE GOLDEN MESSENGER MINE OF THE UNITED GOLD MINES CORPORATION, YORK, MONT.[1]

By S. H. Lorain[2]

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6947."

[2] Mining enginer, Metal Mining Methods Section, Mining Division, U. S. Bureau of Mines.

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INTRODUCTION

This paper is one of a series on mining and milling methods and costs being published by the United States Bureau of Mines.

The Golden Messenger mine, operated by the United Gold Mines Corporation, is in the York-Confederate Gulch mining region in Lewis and Clark County, Mont., 22 miles northeast of the city limits of Helena and about 1 mile north of the town of York. It is the first operation to exploit successfully the low-grade ores of the York-Confederate Gulch area. The unusual vein structure presents some mining problems that have been solved in an interesting manner.

ACKNOWLEDGMENTS

The information contained in this circular was obtained during a visit to the mine in June 1936 and was supplied through the courtesy of J. C. Archibald, general manager of the United Gold Mines Corporation.

The writer also wishes to acknowledge his indebtedness to D. P. Knowles, mine superintendent; R. F. Howe, mill superintendent; and George Bennett, geologist from whose maps the geologic plans and cross-section shown herein were reduced.

For the history and general geology, the writer has drawn freely upon information contained in U.S. Geological Survey Bulletin 842, Metalliferous Deposits of the Greater Helena Mining Region, Montana, by J. T. Pardee and F. C. Schrader.

HISTORY

In common with most gold-mining districts, the first production of the York-Confederate Gulch region came from the placer deposits of the streams draining the area traversed by the gold-bearing veins. This production beginning in the latter half of the nineteenth century, has continued down to the present day, and the estimated total output has been between $17,000,000 and $18,000,000.

Prior to present operations, total production from all veins on the Golden Messenger dike had been estimated at about $500,000, while lode production of the entire York-Confederate Gulch region was estimated at between $550,000 and $800,000.

Among the first quartz veins located in the district was the Little Dandy in 5. Although the Little Dandy was the richest, a number of other veins were ated and worked, particularly in the period from 1895 to 1900. Most of these ns, with the exception of the Golden Messenger, were small, high-grade, and very persistent, although, according to Pardee and Schrader,[3] there is a sibility of developing in this area other commercial deposits comparable in e to the Golden Messenger. This property was included with the Little Dandy a group of claims purchased in 1899 by John and Charles Friedereichs and ers, who incorporated the Columbia Gold Mining & Milling Co.; the Golden senger claims were developed to some extent, and a small mill was built on ut Creek. This mill, which was destroyed by fire in 1902, was capable of y a 35 percent recovery by amalgamation.

In 1913 the York Mining Co. built the present mill (building) and treated onsiderable tonnage by cyanidation. It was followed by other operators, who to 1927 brought the total production from the Golden Messenger claims up to ut 34,000 tons of $6 to $7 gold ore.

In 1927 and 1928 the Golden Messenger Corporation did 2,000 feet of de- pment work on the Golden Messenger veins but made no effort to operate mill.

In 1934 the Golden Messenger mine was taken over by the present operators, remodeled the mill and introduced efficient control of mining operations. ce January 1935 a production of approximately 125 tons per day has been ntained.

ACCESSIBILITY AND CLIMATE

The Golden Messenger mine is reached by a good dirt road from Helena, which sses the Missouri River (Lake Hauser) on a steel bridge at the mouth of Trout ek and thence follows the general course of Trout Creek to York and up Dry ch about 1 mile to the mine, which is at an elevation of 4,200 feet above sea el. This is only 200 feet higher than Helena, and since there are no inter- ing mountains the mine is readily accessible by automobile throughout the year ept during short periods when heavy storms occur.

The climate is semiarid the annual precipitation being 10 to 13 inches. ever, the mine is on the edge of the timbered area of the Belt Mountains, ich lie to the northeast. Mean average monthly temperatures for this section Montana range from a minimum of about 20° F. in January to about 66° in July d August.

GENERAL GEOLOGY

The geology of the region has been described and mapped in detail by Pardee d Schrader,[4] from whose work the following was abstracted:

Pardee, J. T., and Schrader, F. C., Metalliferous Deposits of the Greater Helena Mining Region, Mont.: U. S. Geol. Survey Bull. 842, 1933, p. 144.

Work cited (footnote 3).

The York-Confederate Gulch region is underlain by a series of steeply dipping shaly, slaty, calcareous rocks of the belt series (Algonkian). Along a nearly straight line, from the ridge north of York to Avalanche Gulch, a distance of about 15 miles, these sediments are intruded by a succession of large, vertically dipping, quartz diorite dikes, each of which is 2 to 4 miles long and 300 to 400 feet wide (fig.1).

These dikes, as well as some other intrusives found in the region, have been assigned tentatively to the early or middle Eocene and are probably basic offshoots from the quartz monzonite of the Boulder batholith to the southwest. The lode and vein deposits of the region are invariably associated with these intrusives and lie either within the intrusive rocks or in the adjacent sedimentaries within a short distance of the contact.

The Golden Messenger is the most westerly of the large dikes. It contains the Golden Messenger ore bodies as well as numerous other veins, the most important of which are those of the Little Dandy mine, about 1/2 mile east, and the Golden Charm mine, about 1 1/2 miles west.

MINING GEOLOGY

The veins of the Golden Messenger mine may be classed as the unusual type known as "ladder veins." They comprise a rather closely spaced series that cuts across the strike of the dike so as to suggest the rungs of a ladder.

The predominant strike of these veins is between north and northeast, although there are a number of exceptions, notably the China vein, which strikes almost east and west along the strike of the dike.

The north-south veins dip to the west and east-west veins to the north. The dips of the veins vary; the veins of commercial value so far developed generally dip between 30° and 60°. The bulk of the present production comes from veins with an average dip of about 40°.

Ore bodies of commerical width usually may be classed as lodes formed by compound rather than simple veins. The ore consists of quartz filling and replacement along fractures in the diorite. Widths range from small veinlets up to lodes 30 feet wide, but the usual width of the workable lode is 4 to 10 feet, measured normal to the vein. The lodes usually are confined to the diorite dike and are cut off or become too small to be workable where they cross the contact into the shales. In a few instances, however, small, rich veins have continued into the shales. The first work in the dike was the result of following one of these high-grade veins from the shale into the diorite.

Mineralization consists of pyrite in fine grains or, locally, in thin layers or bands. Grains and tiny bunches of galena and sphalerite occur in places and invariably are accompanied by gold enrichment. The grade generally is uniform, and where the lodes are wide enough and not too badly faulted they are nearly always workable throughout their developed area. The oxidation of the sulphides is nearly complete at the surface. It extends downward below No. 2 level, but at No. 3 tunnel level unaltered sulphides predominate.

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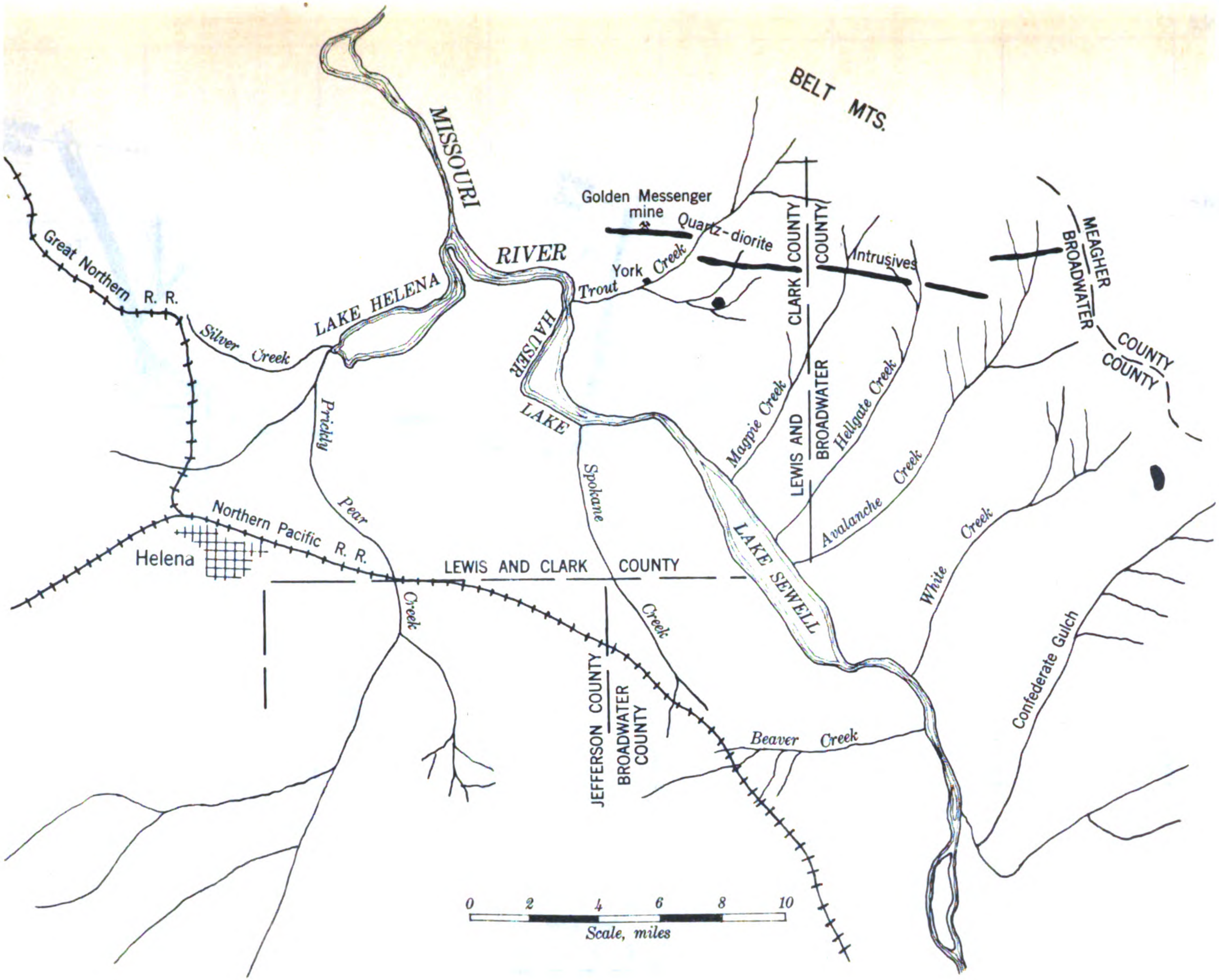

Figure 1.—Location of York-Confederate Gulch region with relation to Helena, Mont.

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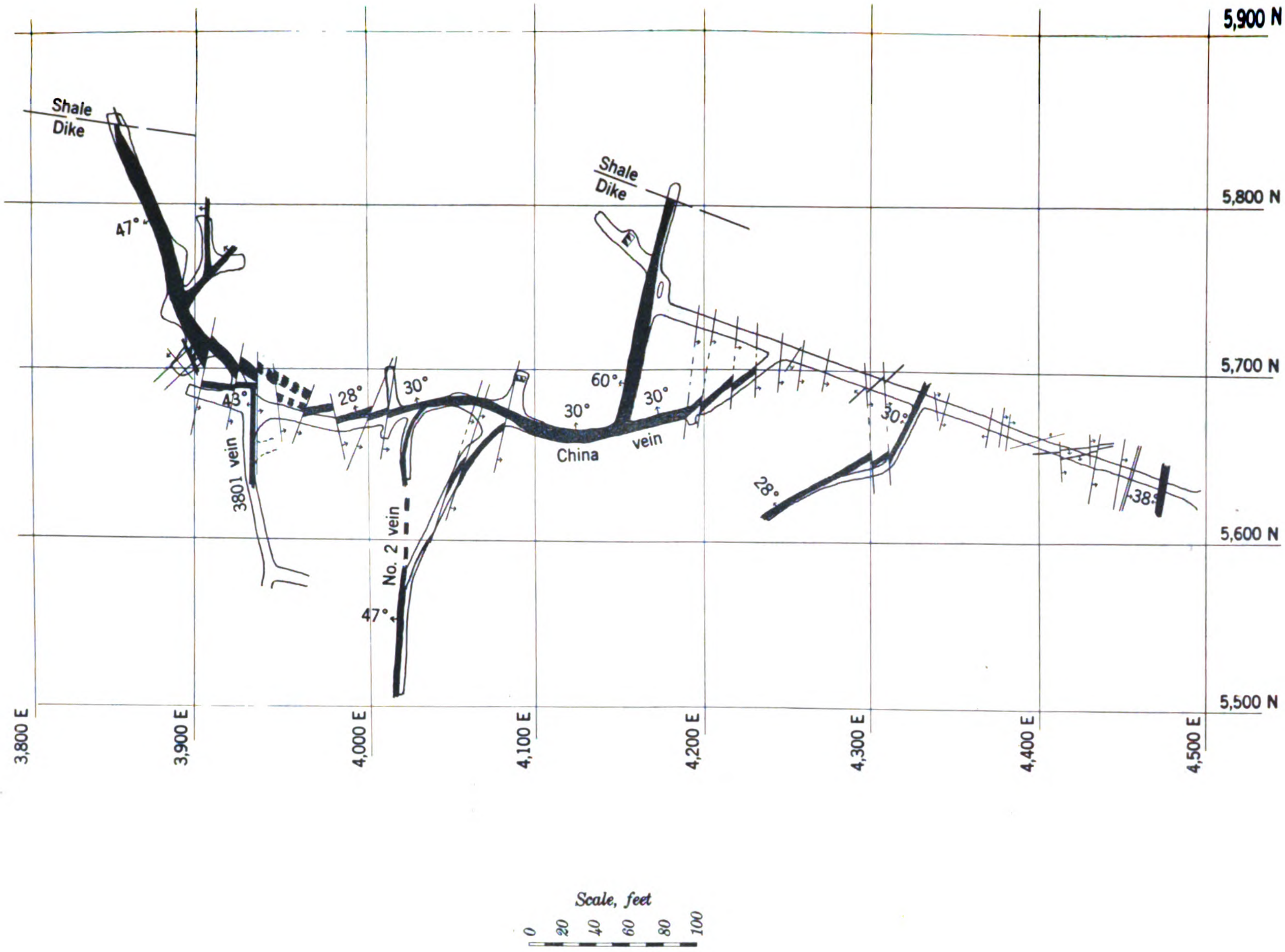

Figure 2.—Plan of no. 2 tunnel level, Golden Messenger mine.

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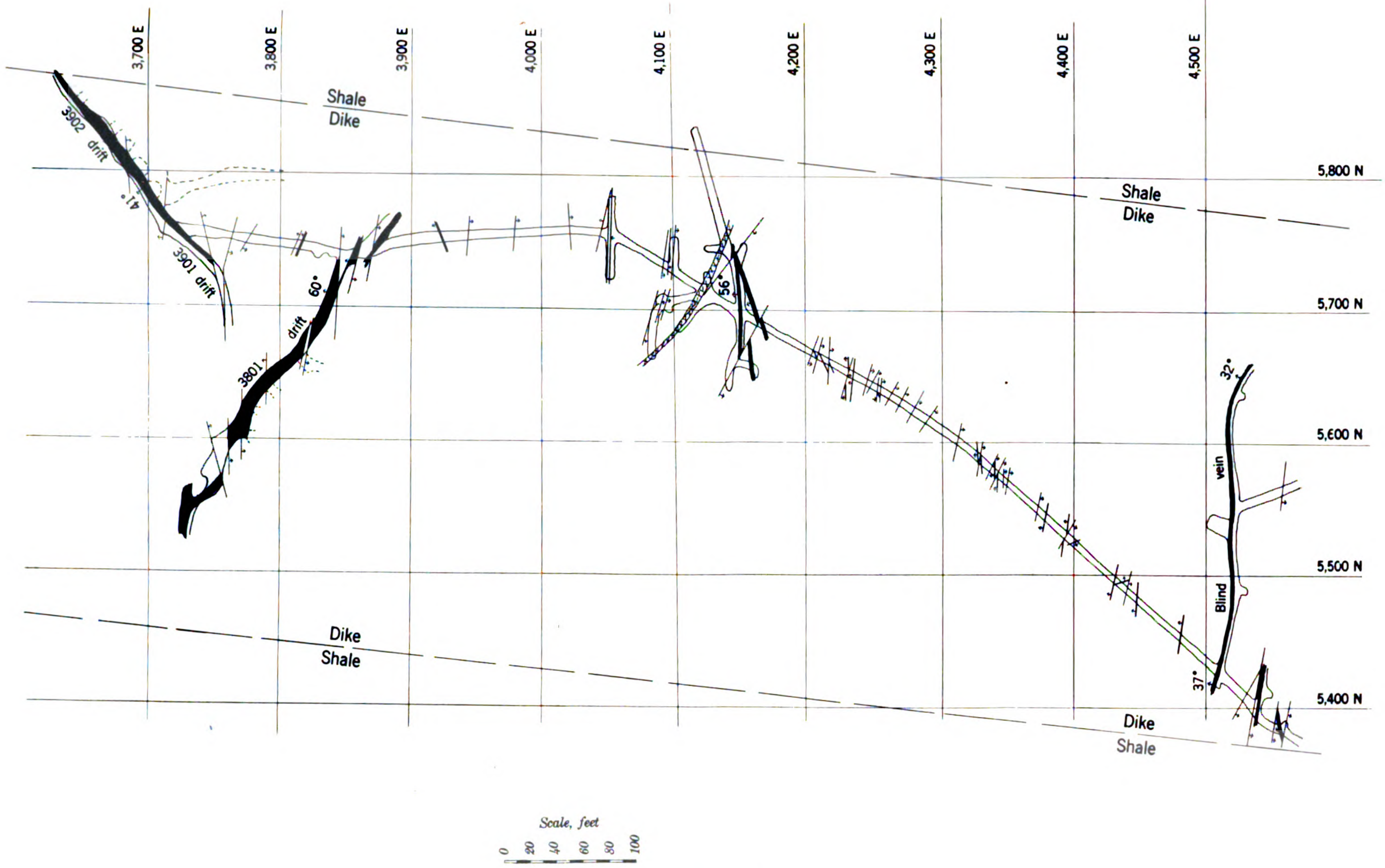


Figure 3.—Plan of no. 3 tunnel level, Golden Messenger mine.

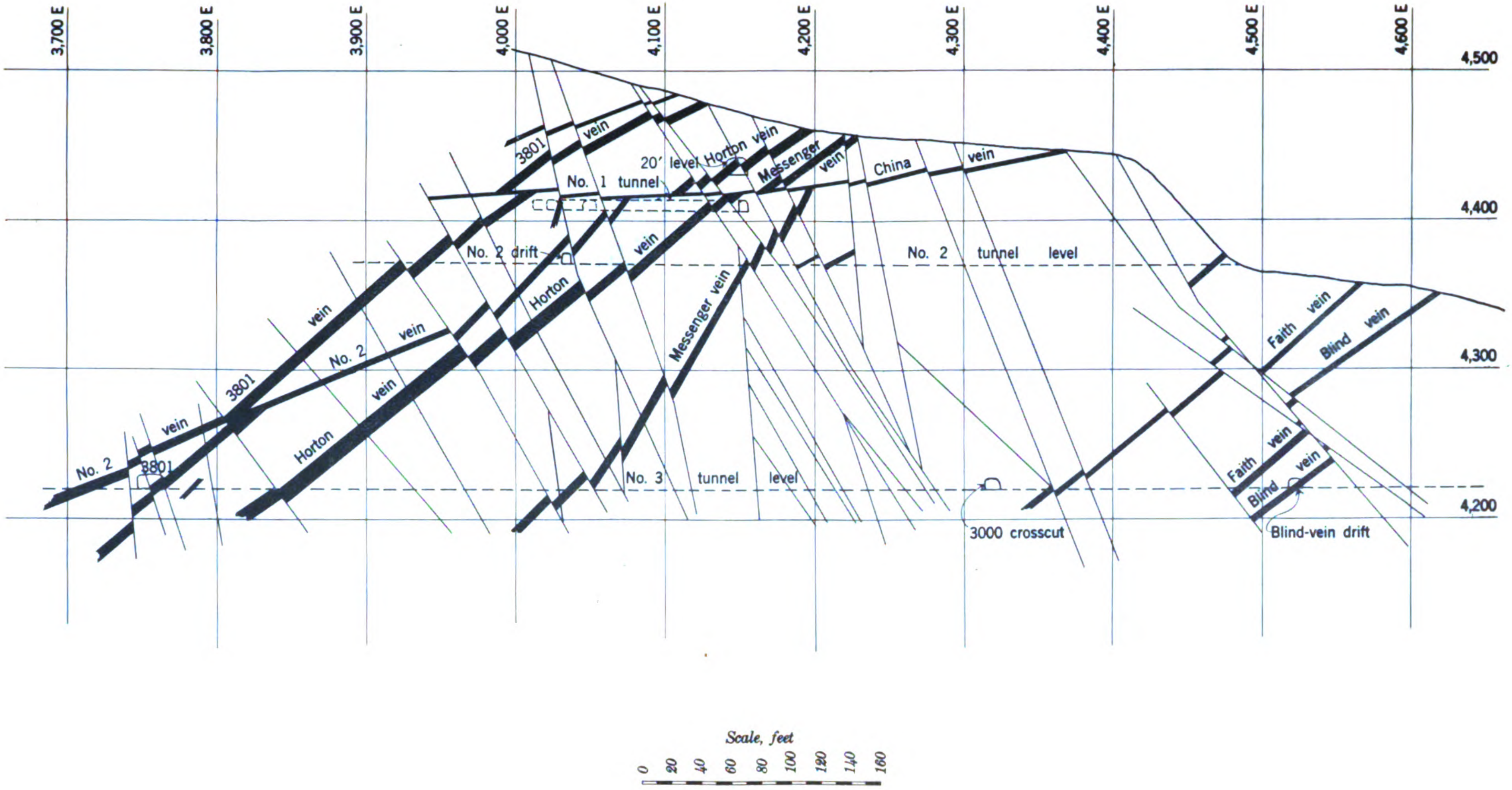
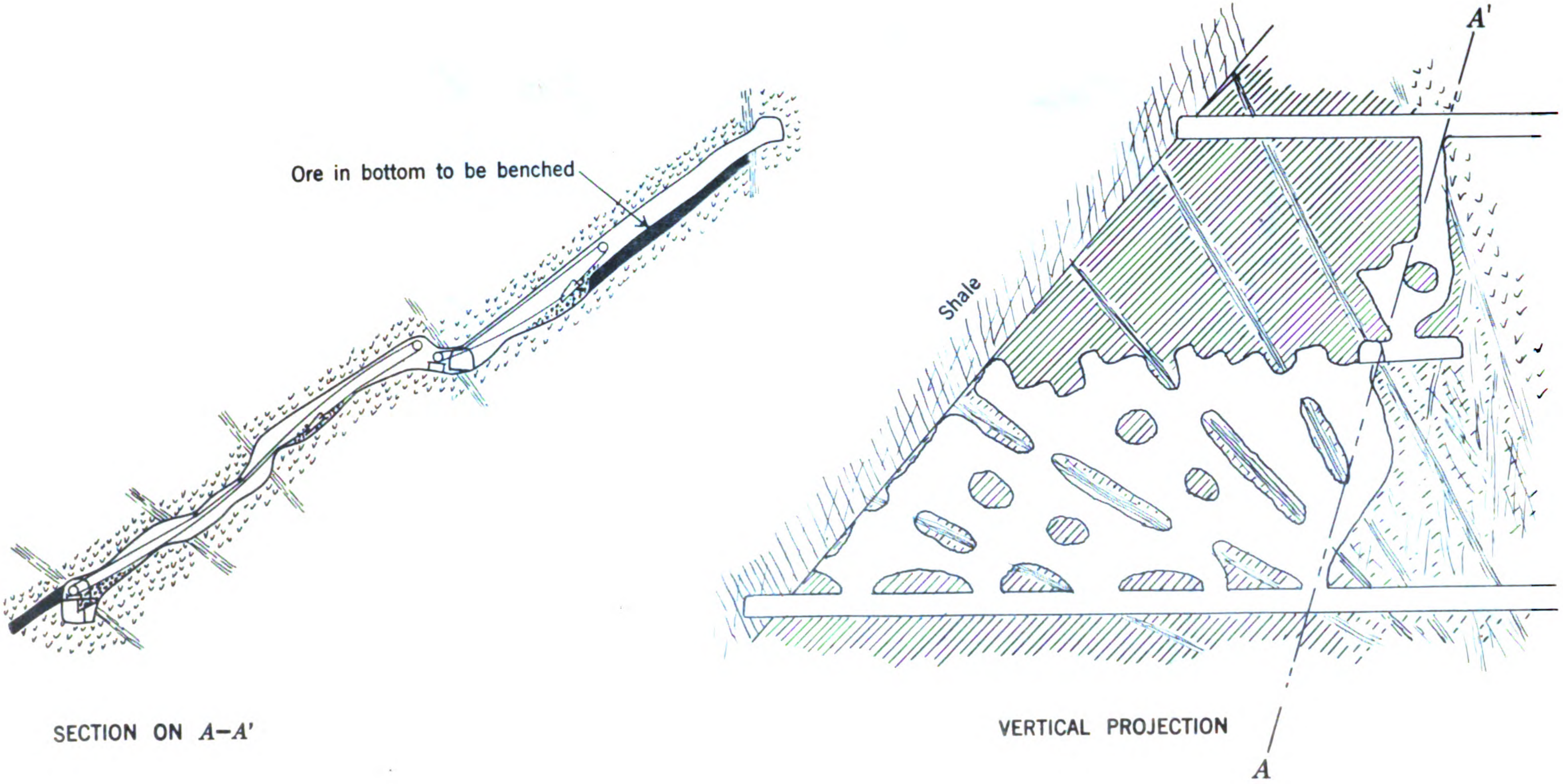


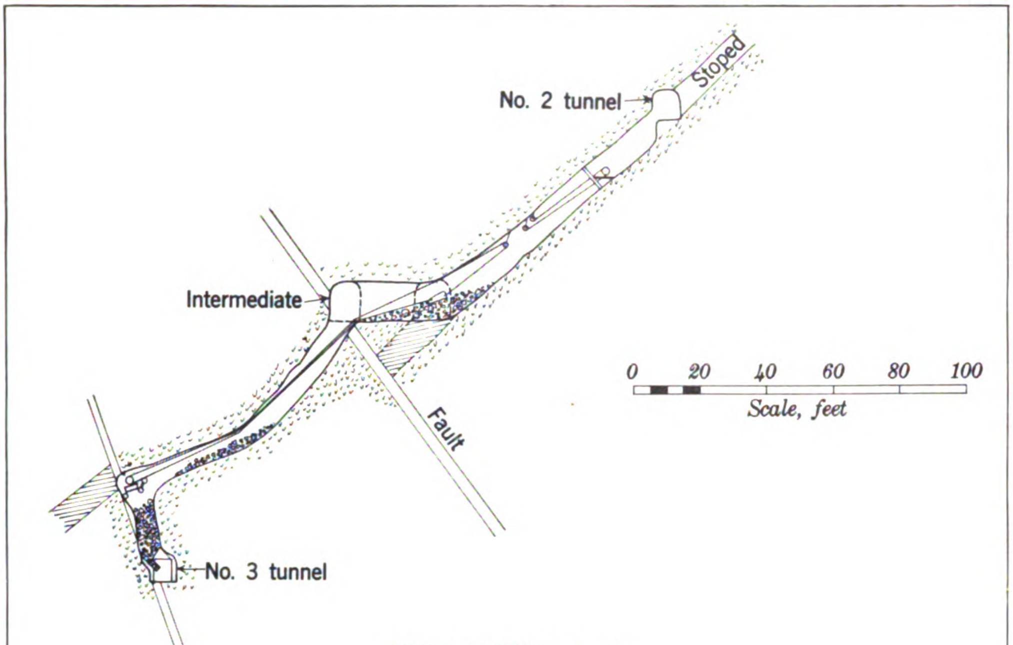
Figure 4.—Cross section, Golden Messenger vein system, on coordinate 5,600 N, looking north.



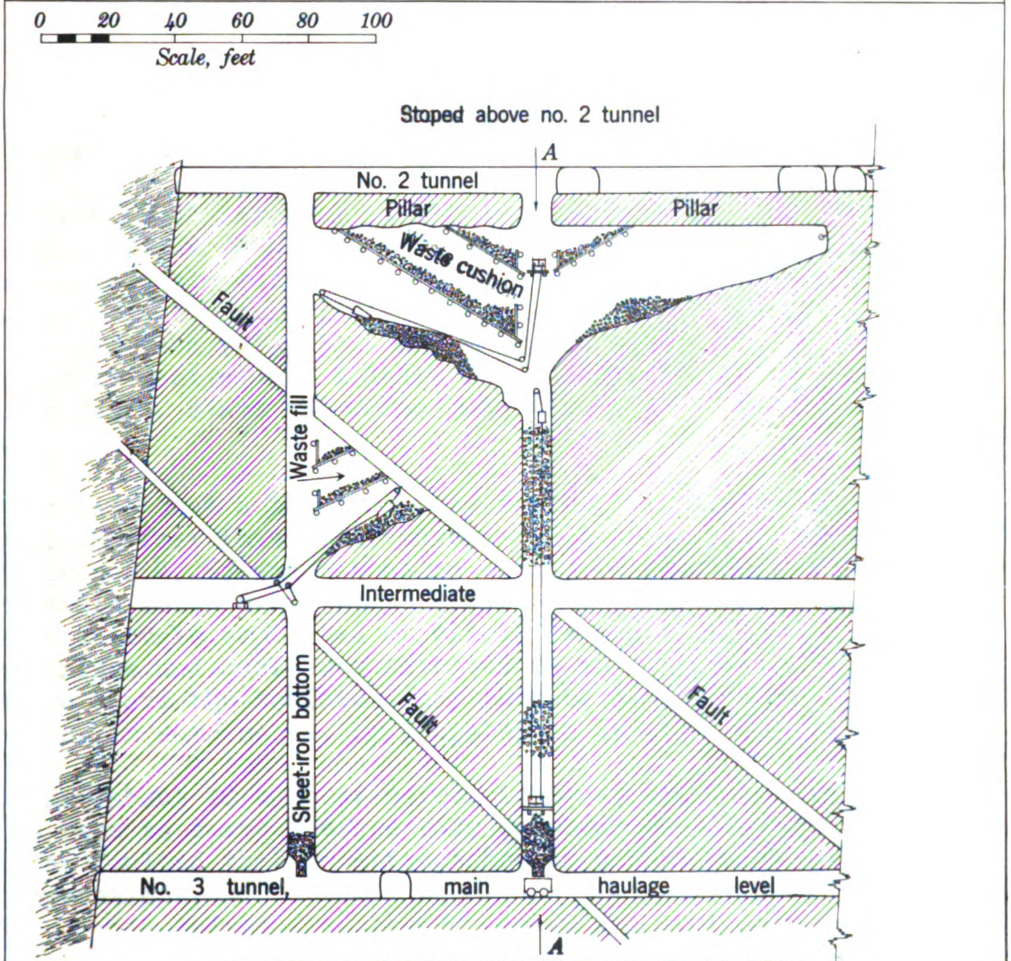
SECTION ON *A–A'*

VERTICAL PROJECTION

Figure 5.—Overhand stoping method.



CROSS SECTION *A–A*



LONGITUDINAL SECTION ON THE PLANE OF THE VEIN

Figure 6.—Underhand stoping method.

A large number of post-mineral faults (figs. 2 and 3) with a predominant north-south or northeasterly-southwesterly strike and an easterly dip, cut the lodes, usually at acute angles. Although the ore fractures and the faults have the same general strike, they almost invariably dip in opposite directions. The average dip of the faults is somewhat greater than that of the ore fractures. Fault displacements usually are small (fig. 4), but the rather close spacing of the faults and the acute angle at which they cut most of the veins in the horizontal plane (figs. 2 and 3) frequently result in a much more complicated vein structure than would be deduced from a casual glance at either a single vertical cross section or a horizontal plan.

DEVELOPMENT

The mine is developed by a number of short adit levels and other openings near the surface; by No. 2 tunnel level, which cuts the ore bodies about 60 to 30 feet vertically below the surface; and by No. 3 tunnel level, which is 150 feet vertically below No. 2. Because of the number and size of the veins available above No. 3 level, no attempt has yet been made at deeper exploration.

Previous operators had no definite plan for exploratory work. The United Gold Mines Corporation, however, recently completed a careful geological survey of the mine workings and employs a geologist to study current geological problems so that development may be directed most effectively and mining conducted efficiently. A set plan of operation, however, does not appear to be possible; each drift, raise, and stope presents a separate problem.

The present level interval is 150 feet vertically, or approximately 250 feet on the dip of the vein. It is important to keep main haulage levels at the maximum practicable interval to reduce development work in waste. This becomes apparent when the relatively short veins are compared with the crosscut distances between them (fig. 3). The westerly strike of the China vein made it possible to drive most of No. 2 level in ore; however, the lower levels will not have this advantage, since the China vein dips out of the dike between No. 2 and No. 3 level.

It is obvious that a lode so badly faulted as this cannot be developed adequately at 250-foot intervals; moreover, it is equally obvious from an examination of figures 4, 5, and 6 that no single intermediate level could be driven that would serve every stope efficiently; therefore, the plan adopted was to keep haulage levels separated as widely as practicable and to develop each ore body by raises and sublevels situated so as to meet each particular condition. The ore above the sublevels may then be transferred to the haulage level by slushing or, in some cases, by dropping it through transfer raises.

Raises are about 10 by 5 or 6 feet in cross section and are located and spaced so as best to serve the ore body in which they are driven. In many cases the vein is so faulted that no attempt has been made to drive raises in advance of stoping operations.

STOPING

Two distinct stoping methods are used. The method most generally employed at present is overhand open-stoping in which the back issupported by small pillars. The other method is underhand stoping, in which the back is permitted to slough to some extent, miners being protected from falling rock by a row of stulls covered with lagging and a thin layer of waste. In both methods virtually all mucking is done by mechanical scrapers.

Overhand Stoping

Virtually all past production has been obtained by the overhand method. The flexibility of this method adapts it to the faulted, irregular ore bodies, since it is necessary to follow the ore from round to round without a set plan or preliminary development. Prior to completion of detailed geological maps, it was necessary to do nearly all mining on a day-to-day basis.

Drift chutes are spaced at 15- to 30-foot centers, depending upon the location of faults (fig. 5) and the dip of the vein; the closer spacing is used on the flatter dips. Drift pillars are left between chutes, and the latter are connected by short, flat raises. At intervals, which vary according to local conditions but may be considered as about 60 to 75 feet, a chute is cut out to accommodate a slusher-hoist installation, as shown in figure 7. Intervening chutes are built in a similar manner but without provision for the hoist. Although it might be possible to pull all the ore to the slusher chute, the use of the intervening chutes greatly increases the speed and efficiency of slushing and also provides more chute storage. The construction of a chute requires the labor of two men for about one shift. When the stope, or that part of it served by the chute, is worked out, the chute is torn out and moved to a new location.

Stoping is begun from the back of the chute raises and follows the ore upward. Mounted or hand-held jackhammers and self-rotated stopers are used for drilling. It is found that in these flat stopes better alinement of holes is obtained and less wear on machine parts and less steel breakage is suffered when mounted jackhammers are used. In narrow sections or tight corners, however, it is frequently necessary to use stopers and hand-held jack-hammers. Where the lode is much more than 6 feet wide, a cut is first carried up next to the hanging, which is carefully barred down, and the ore remaining in the bottom is then benched down with hand-held jackhammers (fig. 5).

Medium-weight jackhammers using 7/8-inch hexagon steel give excellent service in this ground, which generally is easy to drill and break. The highly oxidized ore in the upper levels frequently is soft and crumbly; the unoxidized ore on No. 3 level consists of a mixture of altered quartz diorite and bands of hard quartz. Because of the irregular ore bodies and varying vein widths, there is no standard practice governing depth, spacing, or loading of holes.

Detachable bits are used throughout. New starting bits have a gage of 2-1/4 inches. As the bits wear, they are reground and sorted to give "following" gages.

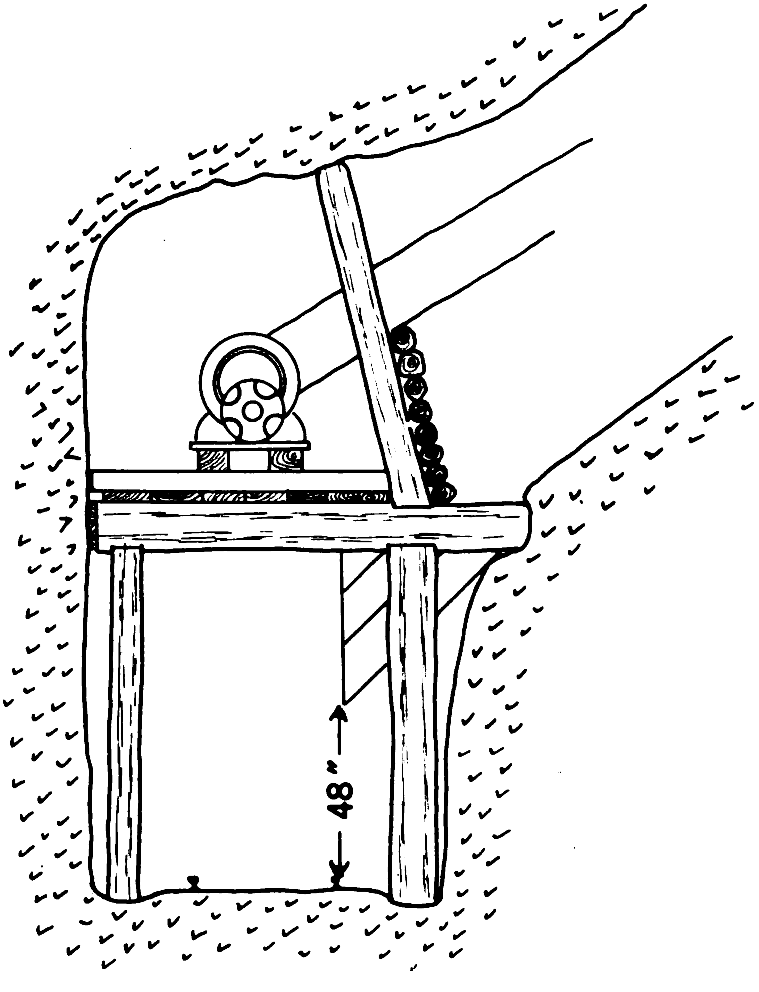


Figure 7.—Chute construction for scraper-hoist installation.

Except for an occasional stull to support a piece of loose hanging, no timber is used in the overhand stopes. The hanging wall is strong and not likely to squeeze. The rock, however, is rather blocky, and small falls of rock are frequent unless the back is supported. This support is provided partly by the natural division of the stope into small segments and is completed by small pillars of ore left within the segments. The more highly faulted stopes (fig.5) are divided into a number of small segments, slightly offset above or below each other and bounded by the planes of faulting. Although it would be possible to carry the stopes without interruption through the minor faults, to do so would involve mining considerable waste from either the hanging or foot walls and would unnecessarily open extra ground. The practice therefore has been to hole through the fault steps only when necessary to facilitate slushing operations. This results in a division of the stope into a number of independent sections, each bounded by planes of faulting. The hanging wall within the individual sections is supported by ore pillars about 10 feet in diameter and spaced 15 feet apart. Between the pillars the back is arched to insure safety. It is expected that a large percentage of these pillars eventually will be recoverable by simultaneous blasting and scraper mucking.

It would be possible to substitute timber support for the ore pillars; however, the height of the back--which is frequently 10 feet or more, measured perpendicular to the vein--and the blocky character of the ground would make necessary the use of large, heavy, closely spaced timbers, which would make timbering expensive. The timber would be subject to damage by heavy blasting and would interfere to some extent with slushing operations. These factors, together with the low-grade ore and the possibility of recovering pillars later, have influenced the decision in favor of ore pillars.

Underhand Stoping

A method of underhand stoping that involves some novel ideas is being tried successfully in one stope. The method is illustrated in figure 6.

The ore is benched downward in successive slices and pulled to a central raise by mechanical scrapers. The bottom of the stope is inclined at a low angle toward the raise, affording secure footing for the miners and permitting the most efficient drilling with hand-held jackhammers. The broken ore is confined to a small area and may be scraped in a short and direct line to the raise. Costs are not yet available but it appears that drilling and scraping may be done more efficiently with the underhand method.

It has been pointed out already that the ground is not likely to squeeze. The support of the hanging wall, therefore, is chiefly to protect miners and prevent dilution. A protective covering is provided above the working slice by successive rows of 8-inch stulls 7 feet apart, lagged over with 3-inch sawed or 3-inch round lagging and cushioned with a thin layer of waste. Inasmuch as the stopes are flat, protection is needed only against rolling rock or glancing blows; moreover, blasting is directed away from rather than toward the timber, consequently heavy stulls are not required. The rows of stulls are spaced 15 to 20 feet apart, depending on the ground. Adequate protection is obtained with a comparatively small amount of light timber, and a high percentage of the ore is extracted.

Although this method entails driving development raises at intervals governed by local conditions, the number of chutes is about half that required by the overhand method. The sublevel development will depend, in each case, upon the size and position of faults.

The stope now being mined by this method is unusually free from faults. It is doubtful if the method will be applicable to the highly faulted areas; however, the management feels certain lower over-all costs will be obtained by this method, where conditions permit its use.

SLUSHING

The mine is equipped with five HDE-7 (7-1/2 horsepower) Sullivan d. c. electric hoists wound with 3/8-inch steel cable. The cable is changed at about 4-month intervals. Thirty-six-inch, box-type scrapers are used. Ordinarily, the hoe-type scraper would be chosen for this type of work, but second-hand box scrapers were available and cheaper; they have served the purpose satisfactorily. Alloy-steel teeth have been riveted to the scraping edge to increase the digging power in blocky ore.

Miners and muckers usually work in pairs. The mucker assists the miner in setting up his machine when necessary and in turn, is, assisted by the miner in rigging the slushing equipment. The ore is slushed into and piled above the chutes. When the chutes are full, stockpiles are built up at convenient localities from which the ore may be pulled quickly to a chute. Because of the flat pitch of the stopes, chute capacity is small and only a few cars may be pulled readily from a chute without going up into the stope to pull down the ore; this slows down loading ore trains. To speed up loading, one of the raises in the underhand stope has been lined with sheet steel so the ore will flow by gravity to the chute. In many places the vein is flattened by faulting to such an extent that the ore will not slide on steel.

At first it was believed that ore could be scraped efficiently the full distance of the level interval, or 250 feet. Trouble with burned-out armatures has led to the conclusion that about half this distance is the maximum for satisfactory operation of the 7-1/2-horsepower hoists under existing conditions.

Ore may be conveniently scraped to chutes about 40 feet on either side of the hoist by using snatch blocks. When scraping is done into side chutes or around corners an extra mucker usually is required to handle the scraper and to do such hand shoveling as may be necessary.

Instead of the usual expanding wedge for anchoring tail and snatch blocks, it has been found to be cheaper and quite as satisfactory to use a piece of broken drill steel with detachable bit threads on one end. An eye is forged on the broken end and an outworn bit screwed on the threaded end, which is then roughly wedged in a hole in the back or wall at such an angle that a direct pull is not exerted on it.

Although the segmented character of the stopes requires the constant availability of a number of slusher rigs, seldom are more than one or two in operation at any one time. The total installed horsepower for scraping is 25.

TRAMMING

All ore is dropped through transfer raises or stopes to the No. 3 tunnel level, from which it is trammed by horses to the mill, a distance of 2,600 feet.

One horse pulls a train of 10 cars each of 0.675-ton capacity. Two horses and two drivers per shift are employed. One driver gathers the cars and the other draws the trains to the mill.

This work is contracted at $0.07 per car. The contractors furnish and feed the horses and pay one driver per shift. The other driver is paid by the company.

LABOR

In June 1936, the following men were employed at the mine:

	Rate per day
19 miners................	$4.50
18 muckers...............	4.25
2 trammers...............	Contract
2 trammers...............	4.25
1 compressor man........	4.25
1 blacksmith............	4.75
2 shift bosses..........	5.00

Against a daily production of 125 tons, this gives an output of 2.78 tons per man shift for all mine labor.

Two machine shifts per day were being employed on drifting (mostly in ore), but as conditions had not yet warranted a separate accounting of stope and development cost, no dependable division can be made.

POWER

The mine is equipped with one 450-cubic foot and one 400-cubic foot compressor, each driven by a 75-horsepower induction motor; one 25-horsepower motor generator set furnished d.c. current for the slushers and a 10-horsepower mine pump. The maximum power load for the mine is about 150 horsepower.

Power is purchased from the Montana Power Co. at a charge of $1 per month per horsepower of maximum demand plus a rate of $0.0061 per kw.-hr. consumed. The energy rate varies according to the peak demand rating, which is 300 horsepower for both mine and mill.

COSTS

Because of the proximity of the mine to the company office in Helena it is possible to combine office expense with that of other operations of the company. In this way it is possible, at small cost, to supply the operating staff with a daily cost sheet, a copy of which is placed in the hands of the superintendents each morning and shows the costs for the preceding day; an abnormal increase in any item is checked immediately. A typical daily mine cost statement follows:

Item	Amount	Per ton (based on 125 T)
Labor	$193.75	$1.550
Supplies	63.75	.510
Power	10.62	.085
Office	3.12	.025
Supervision	5.75	.045
Trucking	2.47	.020
Assaying	5.87	.047
Accident insurance	9.71	.078
Miscellaneous	3.60	.029
Total	$298.64	$2.389

Total cost of mining for the entire month of May 1936 was $2.411 per ton.

Cost of mine supplies and drilling and blasting for May 1936 are included in the following two tables.

Cost of mine supplies (May 1936)

Item	Amount (per ton)	Cost (per ton)
Powder	1.576 pounds	0.2748
Fuse	4.446 feet	.0309
Caps	.717	.0095
Carbide	.098 pound	.0067
New jackbits	.172	.0548
New Timken bits	.013	.0042
Bitting, shanking, threading steel		.0315
New drill steel		.0191
Reground bits	.210	.0223
Airhose, drill parts		.0450
Lubricants		.0136
		$.5124

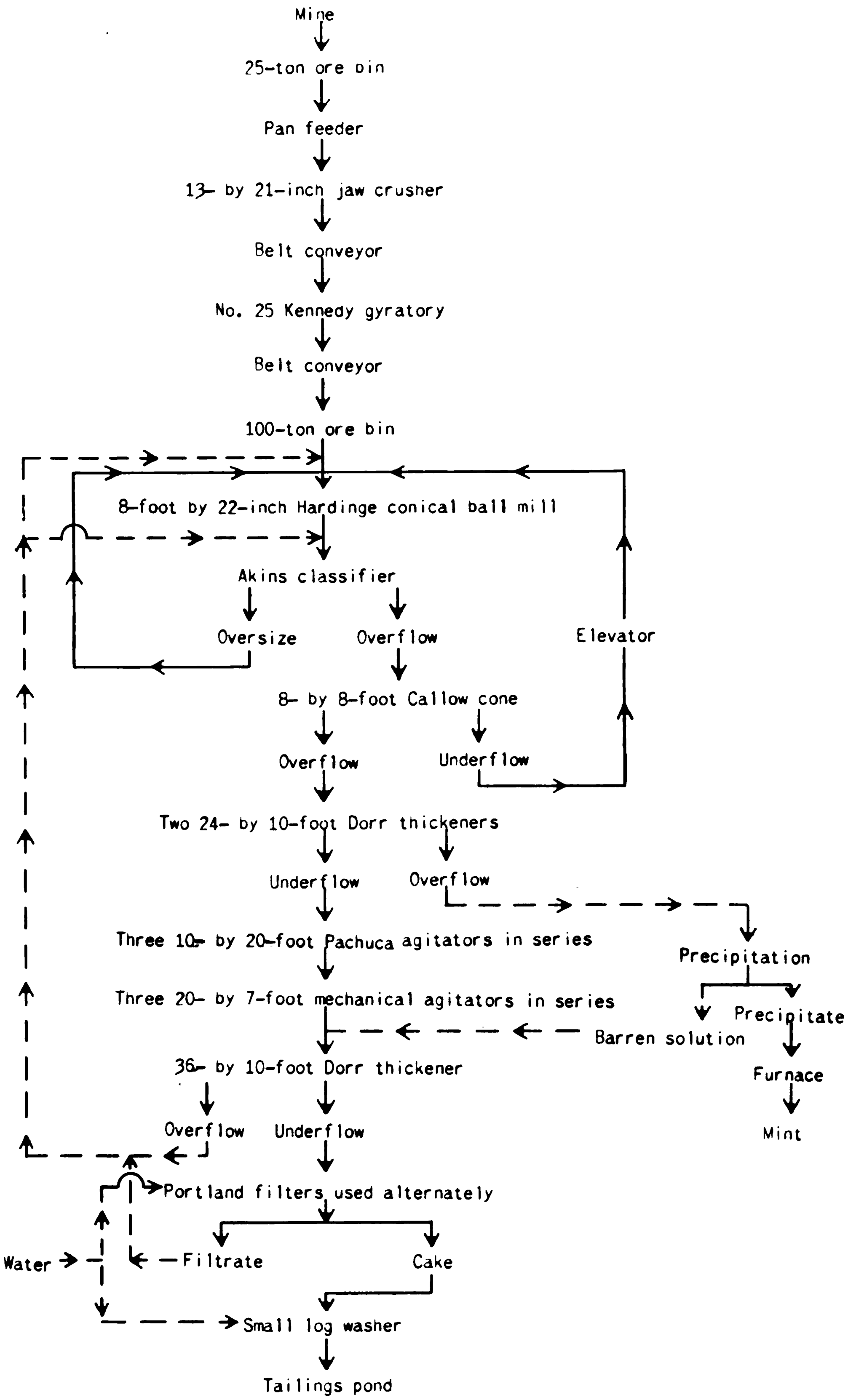


Figure 8.- Flow sheet, Golden Messenger mill.

Drilling and blasting cost (May 1936)

Item	Cost (per ton)
Labor	0.5060
Parts, steel, bits, sharpening, airline	.1178
New bits, powder, fuse, caps	.3659
Power	.0854
	1.0751

MILLING

The Golden Messenger ore is treated by straight cyanidation. The present mill building was built by the York Mining Co. in 1913, and a considerable tonnage of ore was treated by cyanidation prior to 1927.

Upon beginning operations in 1935, the present company utilized the old mill building and much of the equipment left by earlier operators. Consequently, the set-up is not all that the management desires. Nevertheless, the requirement of low first cost, which was important at that stage of the operation, was fulfilled and, up to now, extraction has been reasonably satisfactory.

However, mining increasing quantities of unoxidized ore from the lower level has been accompanied by decreased extraction because of insufficient grinding. Tests have indicated that gold locked in the coarser sulphides is chiefly responsible for the loss. It is planned to make a table concentration of sulphides and return the concentrates in closed circuit with the ball mill until they are sufficiently slimed to pass off with the table tails. This will achieve the desired result without throwing a heavy additional load on the grinding circuit. Further tests indicate that a period of agitation should precede the first thickening (fig. 8) of the pulp. This change would permit more of the gold to be removed from the circuit quickly and would cause lower grade solutions to go to the last (No.3) thickener and thus reduce the dissolved loss.

The following description applies to the mill operations in June 1936. The flow sheet is shown in figure 8.

Crushing

Ore is brought from the mine in horse-drawn trains of 10 cars each. The cars are dumped into a bin of 25 tons capacity, from which the ore is fed by a pan feeder to a 13- by 21-inch Blake type jaw crusher set for a 2-inch discharge. The crusher man sorts about 120 tons of waste per month from the ore as it passes over the pan feeder.

From the jaw crusher the ore moves over a short belt conveyor to a No. 25 Kennedy gyratory set for a 3/4-inch discharge, thence by belt to a 100-ton fine-ore bin.

Grinding and classification

Grinding is done in cyanide solution in an 8-foot by 22-inch Hardinge conical ball mill operating in closed circuit with a 4- by 18-foot Akins classifier and an 8- by 8-foot Callow cone used as a supplementary classifier. The underflow from the cone is returned by elevator and launder to the ball-mill feed. The ore is ground to 95 percent through 65-mesh.

Cyanidation

From the cone-classifier overflow the pulp passes to two 24- by 10-foot Dorr thickeners arranged in parallel. The pregnant solution overflow, assaying about 0.038 ounce gold, goes to the precipitation. The pulp, which contains 55 percent solids, goes to a series of three 10- by 20-foot Pachuca agitators followed by another series of three 20- by 7-foot mechanical agitators, which were converted from old leaching tanks by the installation of paddles. Solutions are maintained at a strength of 1 pound of free cyanide and 1/2 pound protective alkalinity per ton of solution. The total time of agitation is between 40 and 45 hours. Cyanide consumption is 0.6 pound and lime consumption is between 5 and 6 pounds per ton of ore treated.

From the agitators the pulp goes to a 36- by 10-foot Dorr thickener, from which it is discharged to the filters.

Barren solution is added to the last thickener; the overflow goes to the ball mill- classifier circuit.

No diaphragm pumps are used in the circuit. A centrifugal slime pump is used to elevate the pulp from the Pachuca tanks to the mechanical agitators. Otherwise, all pulp flow is by gravity, the pulp density being controlled by bushings in the thickener discharge pipes.

The final thickener is outside the mill building, but no trouble has been experienced from freezing even during a 3 week period when the temperature did not rise above zero.

Filtering

Pulp is delivered to the filters at about 60 percent solids. One 12- by 12-foot and one 9- by 12-foot Portland filter are used alternately. Cakes contain 20 to 25 percent moisture; they are repulped in small log washers and diluted with mine water to approximately a 1 to 1 ratio. The pulp is then carried by launder to the tailings pond.

Water consumption

The only water added to the mill circuit is that needed to replace the evaporation loss and the solution lost in the filter cakes. Additional water is required for tailings disposal as noted above. These requirements are met by 18 gallons of water per minute, which is all that the mine makes. This is less than the theoretical requirements, as indicated under "Filtering," so it would seem probable that the pulp is actually being carried to tailings at higher than a 50-percent density.

Extraction

On oxidized ores a tailing averaging about 0.02 ounce of gold per ton has been obtained, which, with a 0.20-ounce head, gives an extraction of 90 percent. As already stated, the recent increase in the proportion of unoxidized ore has resulted in poorer extraction. It is believed, however, that the contemplated ntroduction of selective fine grinding of the sulphides will overcome this trouble.

Melting

Precipitates are melted in an ordinary tilting furnace, the following charge being used:

	Parts
Borax.........	30
Soda ash......	8
Glass.........	5
Precipitate...	57

Crucibles last about 1 month, or for four melts. The cost of melting (May 1936) was $56.49, or $0.013 per ton of ore treated.

Labor

Eleven men, in addition to the superintendent, are employed in the mill and for tailings disposal. These are distributed as follows:

	Rate per day
3 operators (1 each shift).....................	4.75
3 helpers (1 each shift).......................	4.50
2 crusher men (day and afternoon)..............	4.25
1 repair man (day).............................	4.50
2 tailings dam attendants (day and afternoon)..	4.25

This gives a tonnage milled, per man shift, of 11.36 tons, based on a tonnage of 125 tons per day. (The tonnage in May 1936 was actually about 130 tons per day.)

Power

Connected horsepower for mill purposes is as follows:

Jaw crusher and conveyors......	50
Gyratory.......................	20
Ball mill-classifier circuit...	100
Mill compressor (150 cu. ft.)..	
Mechanical agitators...........	70
Misc. (pumps, etc.)	
	240

Actual peak demand for mill operation does not exceed 150 horsepower.

Costs

A typical daily mill cost statement follows:

Item	Amount	Per ton (on 125 T)
Labor	$ 68.62	$0.549
Supplies	36.13	.288
Power	32.04	.257
Office	3.12	.025
Supervision	5.75	.045
Trucking	2.47	.020
Assaying	3.03	.024
Accident insurance	1.82	.015
Fire insurance	2.78	.022
Miscellaneous	3.60	.029
	159.36	1.274

Actual total mill cost for the entire month of May 1936 was $1.21 per ton.

Cost of Mill Supplies (May 1936)

Item	Amount per ton, pounds	Cost per ton
Cyanide	0.609	$0.1149
Lime	6.190	.0554
Zinc	.273	.0332
Balls	2.312	.0644
Lubricants	—	.0061
		.2740

TOTAL COST SUMMARY

The following is a summary of all costs at the Golden Messenger for May 1936.

	Per ton
Mining	$2.411
Milling	1.212
Melting	.013
Total operating	3.636